P/2803-42

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

Chang Je CHO

Date: March 5, 2003

Serial No.: 09/914,103

Group Art Unit: 2826

Filed: August 22, 2001

Examiner: Johannes P. Mondt

For: RECTIFIER OF THERMALLY MOVING ELECTRONS AND METHOD OF CONVERTING THERMAL ENERGY INTO ELECTRIC ENERGY BY USING THE SAME

Asst. Commissioner for Patents
Washington, D.C. 20231

DECLARATION OF CHANG JE CHO UNDER 37 C.F.R. §1.132

Sir:

Chang Jo CHO declares as follows:

1. I am the named inventor on the above-identified patent application.

2. I am informed that in an Office Action dated March 20, 2002, in paragraphs 2, 4 and 5, the Examiner has requested certain information concerning the operability of and data collected for an apparatus of the present invention.

3. I enclose hereto as Exhibit A, a statement which I believe is responsive to the request made in this Office Action and which is based on actual data and information known to me.

4. I further declare that all statements made herein are made of my own knowledge and are true except for those statements made on information and belief, which are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this declaration of this application and any United States patent issuing therefrom.

march 4, 2003
Date

Chang Je Cho
Chang Je CHO

EXHIBIT A to DECLARATION OF CHANG JE CHO UNDER 37 C.F.R. §1.132

<Materials for the Supplemental Submission>

1. Manufacturing method of the Prototype Apparatus

1.1 Manufacturing process

The applicant manufactured the prototype apparatus in accordance with the following sequential process:

1) Prepare a piece of P-type Si wafer of which size is 110mmx110mm.
2) Treat the Si wafer with HF acid to remove an oxidized film on its surface.
3) Load the HF acid treated Si wafer into a vacuum deposition equipment.
4) Heat the Si wafer to 160°C in an atmosphere of $2x10^{-6}$ torr in order to dehydrate the Si wafer, and then cool down the Si wafer under 30°C.
5) Preliminarily deposit a little amount of Ge in a moment onto the cooled Si wafer in order to make cores.
6) Heat the Si wafer to 400°C rapidly and perform additional deposition of Ge in an atmosphere of $5x10^{-6}$ torr to magnify the cores.
7) Heat the Si wafer to 520°C rapidly and keep the heated Si wafer in a pressure condition, 10^{-3} torr, of a rotary pump for 20~30 seconds in order to oxidize the surface of the Si wafer. However, this processing step is optional and may be omitted when low temperature sputtering is applied.
8) Exhaust a chamber of the equipment to a high degree of vacuum. Then, have H_2 gas introduced into the chamber and have the chamber rapidly cooled to prevent nano particles from being oxidized.
9) Load the Si wafer treated as such on a sputtering apparatus.
10) Perform a DC sputtering, with SnO_2 as a target (negative electrode) of the Si wafer in an atmosphere of Ar gas, where the depth of SnO_2 layer is controlled by the processing time and current amount, in order to obtain P-N heterojunction. The SnO_2 target for the sputtering can be made on a surface of an N-type Si wafer by a simple chemical vapor deposition (CVD).
11) The prototype apparatus can be made through the above-mentioned sequential processes. With the prototype apparatus, perform the measurement of electromotive force (emf) to prove the enablement of the present invention.

1.2 Particularity of the manufacturing process

1) The rectifying barrier of a predetermined depth is an area of the P-type Si side within a narrow depletion region which is formed by a hetero-junction of a high impurity concentration P-type Si wafer such as Boron dopant Si wafer, of which resistivity is 0.01~0.02 and carrier concentration is about $1\sim1.5x10^{19}/cm^3$, and an N-type semiconductor SnO_2, of which carrier concentration is higher than $10^{20}/cm^3$. The value of the depth of the rectifying barrier can be controlled by varying the carrier concentration of the SnO_2 which is an N-type semiconductor. The control method of the carrier concentration of the SnO_2 is to control the effective carrier concentration by making an abundance of an amorphous

component within the SnO_2 material increased or decreased. The amorphous component in the SnO_2 can be made by using a sputtering process while varying a substrate temperature or a low-temperature sputtering process with a post heat-treatment at a proper temperature.

2) The nano-particles are made from the island structured Ge which is formed by vacuum evaporation on a surface of the P-type Si wafer.
3) The charge movement barrier layer is the area of N-type SnO_2 side of the depletion layer.
4) Since the nano-particles are located to contact with a P-N junction and biased to the N-type semiconductor, it is required that the P-type carrier concentration be several times as great as the N-type carrier concentration.
5) It cannot be said that the Si-SnO_2 hetrojunction is the best mode in manufacturing the prototype apparatus. The SnO_2 material is reduction type (or excess type) semiconductor. When the SnO_2 is contacted with Si at a high temperature, the SnO_2 is reduced to create an increasing conductivity portion which may act as an obstacle in forming a perfect depletion region and have a bad effect on the insulation between the nano-particles located in the P-N junction. However, the Si-SnO_2 hetrojunction is employed for manufacturing the prototype apparatus for the reasons that the carrier concentration can be controlled and the N-type high concentration carrier material can be easily obtained. The above-mentioned problems could be suppressed by a method of sputtering the Si-SnO_2 after forming an oxidation layer with a depth of several times of atom diameter on a surface of the P-type Si wafer or by a sputtering method of low substrate temperature.

1.3 Structure of the Prototype Apparatus

The prototype apparatus has the structure as shown in reference figure 1. The structure corresponds to the definition on the structure of the apparatus claimed by claim 1.

2. Measuring tool of the output of the prototype apparatus

The PCLD-789D amplifier and multiplexer board, the PLC-816 ADC card and Advantech Genie program of Advantech Co., Ltd., which is a USA company, were used for the measuring of the output voltage of the prototype apparatus, together with auxiliary elements such as an Au needle, a capacitor and a resistor. The PCLD-789D is a front-end signal conditioning and channel multiplexing daughterboard for use with PC-LabCard analog input ports. It multiplexes 16 differential input channels into one of the A/D converter's (PLC-816 ADC card) input channels. For more information about the PCLD-789D, please refer to the following web address. The PLC-816 ADC card converts the analog output voltage into digital and reads, with the assistance of the Genie program, the value of the output voltage across the resistor.

http://www.advantech.com/products/Model_Detail.asp?model_id=1@30322

3. Measuring method
   The reference figure 2 is a block diagram for measuring the output electromotive force (emf) of the prototype apparatus. The emf generated by the prototype apparatus makes the capacitor charged while the charged energy of the capacitor is discharged through the resistor to be dissipated into heat. With the above-mentioned measuring condition, we can say that if any voltage is continuously developed across the resistor against the heat dissipation by the resistor, the prototype apparatus continuously generates some effective magnitude of the emf.

   The measuring was performed with respect to a prototype apparatus that had been 10 days old after the manufacturing date, for 12 hours, per 5 minutes. Temperature and humidity of the measuring chamber were as follows: 22°C and 40%, respectively, in an initial stage; and 20°C and 36%, respectively, in an end stage.

4. Results of the Measuring and Applicant's Opinion
   (1) Detailed results of the measuring are shown in table 1 and graph 1. The results show that a certain voltage of which values are ranged 0.0065~0.0091[V] was continuously developed across the resistor all the time of the measuring. There was no energy generating means, except the prototype apparatus, in the measuring system of reference figure 2. Accordingly, we can conclude that these results can improve a phenomenon that a certain magnitude of the emf was continuously generated by the prototype apparatus.

   (2) In the measuring of the output, phenomena that were regarded to happen due to carrier excess or carrier deficiency could be observed even when the sputtering process, without any particular heating process to a substrate, was performed in manufacturing prototype. In general the measured emf values are around 1 mV. When the SnO_2 target was heated on a heated plate of about 450°C in the air to oxidize the surface of the SnO_2 target for reducing the carrier concentration, and the SnO_2 layer, which was N-type semiconductor, was properly thin, the measured voltage across the resistor was 6~17[mV]. It is the applicant's opinion that a larger emf, e. g., 130[mV] will be generated by the prototype apparatus if the more optimal conditions are applied to manufacturing the prototype apparatus.

   (3) It was observed that when the carrier concentration was too low or too high or the depth of the SnO_2 layer was too thick or too thin in accordance with a oxidation degree of the SnO_2 target surface, the output emf level was sensitively reduced to have about 1[mV]. It was further observed that the emf value of the prototype apparatus sensitively depended on a condition of the carrier concentration of the SnO_2 layer and the depth of the SnO_2 layer, and

also varied by the changes of the humidity and the temperature of the measuring chamber. These phenomena can be understood in connection with some factors such as a relationship between magnitude of the respective nano particles and depth of the rectifying barrier, capability of insulation between the nano particles, the best depth of the charge movement barrier, and etc.

(4) The possibility of rectifying the thermally-activated moving electrons in a thermal equilibrium state has not been authorized by the orthodox school. However, the ground of the orthodox school's doubt is merely theoretical. It is the applicant's opinion that any real experiment and/or measurement should be prior to any theory and accordingly, the results of the measuring at mentioned above should be properly evaluated as they are.

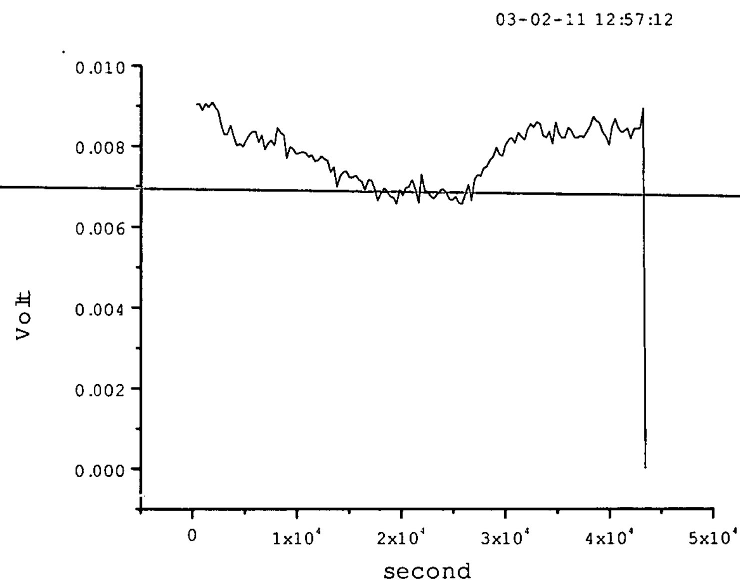
* Table 1. Measuring result of the output emf generated by the prototype apparatus

Measuring Time (Sec)	Output Emf (Volt)
300	0.00903
600	0.00906
900	0.00887
1200	0.00906
1500	0.00895
1800	0.00908
2100	0.00895
2400	0.00885
2700	0.00853
3000	0.00829
3300	0.00829
3600	0.0085
3900	0.00821
4200	0.008
4500	0.00805
4799	0.00798
5099	0.00813
5399	0.00827
5699	0.00835
5999	0.00835
6299	0.00808
6599	0.00827
6899	0.0079
7199	0.00805
7499	0.00813
7799	0.008
8099	0.00845
8399	0.00832
8699	0.00827
8999	0.00769
9299	0.00798
9599	0.00792
9899	0.00779
10199	0.00782
10499	0.00784
10799	0.00782
11099	0.00771
11399	0.00776
11698	0.00761
11998	0.00763
12298	0.00774
12598	0.00766
12898	0.00763
13198	0.00734
13498	0.00747
13798	0.00697
14098	0.00724
14398	0.00734

14698	0.00737
14998	0.00721
15298	0.00721
15598	0.00726
15898	0.00716
16198	0.0071
16498	0.00689
16798	0.00716
17098	0.00713
17398	0.00692
17698	0.00663
17998	0.00681
18297	0.00695
18597	0.00684
18897	0.00673
19197	0.00671
19497	0.00655
19797	0.00689
20097	0.00676
20397	0.00695
20697	0.00697
20997	0.00716
21297	0.00692
21597	0.00658
21897	0.00729
22197	0.00689
22497	0.00684
22797	0.00673
23097	0.00668
23397	0.00679
23697	0.00689
23997	0.00692
24297	0.00679
24597	0.00666
24896	0.00666
25196	0.00673
25496	0.00658
25796	0.00655
26096	0.00679
26396	0.00703
26696	0.00663
26996	0.00716
27296	0.00726
27596	0.00724
27896	0.00742
28196	0.00747
28496	0.00763
28796	0.00771
29096	0.00795
29396	0.00776
29696	0.00774
29996	0.008
30296	0.00813
30596	0.00819

30896	0.00805
31196	0.00832
31495	0.00821
31795	0.00813
32095	0.0084
32395	0.00853
32695	0.00845
32995	0.00858
33295	0.00853
33595	0.00824
33895	0.00819
34195	0.00835
34495	0.00803
34795	0.00858
35095	0.00829
35395	0.00819
35695	0.00819
35995	0.00845
36295	0.00835
36595	0.00819
36895	0.00819
37195	0.00824
37495	0.00819
37795	0.00835
38095	0.00848
38394	0.00872
38694	0.00861
38994	0.00856
39294	0.00832
39594	0.00821
39894	0.008
40194	0.00845
40494	0.00866
40794	0.00843
41094	0.00832
41394	0.00835
41694	0.00843
41994	0.00816
42294	0.0084
42594	0.00843
42894	0.00843
43194	0.00893

*Graph 1. Graph of the measuring result of Table 1.



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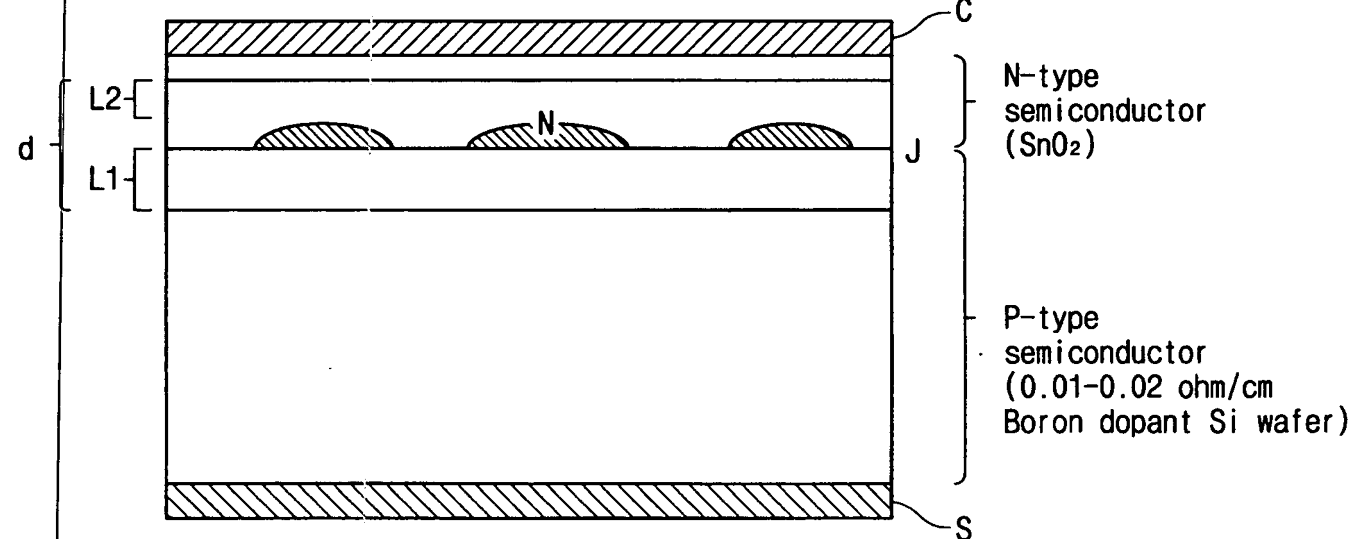
Reference Figure 1

Structure of a prototype apparatus

d: depletion region
L1: rectifying barrier
L2: charge movement barrier
J: P-N heterojunction
N: nano particle(Ge island structure)
C: collector electrode
S: source electrode



Reference Figure 2

Block diagram of a measuring system for the emf of the prototype apparatus